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AGRICULTURAL MEMORANDUM 447

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Relation between β glucan content of barley grain and the weather

The Problem

In the brewing industry difficulties can arise due to high viscosities caused by small quantities of polysaccharides with high molecular weights eg β glucan. A Guiness Son and Company Limited have supplied data on β glucan contents of barley grain grown in different areas of Britain during 1971. Although the glucan contents were determined quite accurately the precise locations where the barley was grown were not available, in some cases only the county and approximate height above sea level were given. In view of this only general statements may be made about the possible relation between glucan content and the weather, on the basis of present data.

Phenology

The majority of sugar polymerisation in the barley grain occurs during the milky ripe stage, but small changes may also occur right up to dead ripeness. It is assumed that β glucan is formed during the milk stage and possibly up to dead ripeness as well.

The date in June of ear emergence, E, was estimated by the equation

$$E = -4.9\,T + 7.4\,M + 56 \qquad \text{(Ag. Mem. 412)}$$

T is the mean air temperature in May °C.

M is the severity of mildew attack on the scale M = 1 (no mildew), M = 2 (moderate attack), M = 3 (severe attack).

Data on mildew were not available, but in 1971 some mildew was known to exist in the grain areas of England, and Yellow Rust was widespread due to the wet, cool weather in June. In view of this M was set equal to 2 for all areas.

The duration, D, of the ear emergence to dead ripeness phase was estimated using

$$D = 123.5\,\frac{1}{P} - 3.64\,N + 70.3 \qquad \text{(Ag. Mem. 446)}$$

P is the mean daily potential transpiration during grain drying (from the end of milk ripeness to dead ripeness). For simplicity this was taken as the month of July.

N is the mean daylength (including twilight) during the grain filling stage.

These regression equations were obtained for Kenia barley. Other varieties are likely to be consistently earlier/later than Kenia, but since the mean error in the estimated date of dead ripeness is 4 to 5 days these differences due to variety will be ignored.

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Estimated Phenology Table

	Devon	Fife	Hants		Lincs	Norfolk
			Altitude 95 m	160 m		
Ear Emergence	13 June	18 June	13 June	15 June	18 June	16 June
Milk Stage	3-13 July	7-17 July	3-13 July	5-15 July	8-18 July	7-17 July
Dead Ripe	19 July	1 August	20 July	22 July	27 July	30 July
Harvest	N.A.	N.A.	30 July - 24 August		4-12 August	N.A.

β Glucan Content (percentage by weight)

	Devon	Fife	Hants	Lincs	Norfolk
Julia	-	1.52	1.85	1.85	1.71
Maris Otter	0.97	1.08	1.27	1.31	1.49
Proctor	1.66	-	1.46	1.65	1.35
Sultan	-	1.50	1.69	2.16	1.53
Zephyr	1.98	1.70	2.09	2.28	1.75

There is a tendency for the glucan content to depend upon variety. In nearly all areas Zephyr has the highest content and Maris Otter the least. Also, Lincolnshire and Hampshire have generelly higher glucan values than Fife or Norfolk.

Weather and Glucan Content

June 1971 was wet in Devon and Hampshire ($>$ 100 mm), but Norfolk, Fife and Lincolnshire were drier (about 50 mm). July was dry and sunny in Devon and Hampshire (9-10 hrs/day sunshine with 25 mm or less of rain). Norfolk was sunny (8 hrs/day), but thunderstorms occurred on 11th and also towards the end of the month. Lincolnshire generally had less than 25 mm of rain with 7 to 8 hours of sun per day. Much of Fife had rainfall totals in excess of 75 mm, most of it falling between 17 and 24 July. Sunshine averaged about 7 hrs/day.

No obvious relation was found between glucan content and maximum temperature or sun hours averaged over the period from the start of milk ripeness to dead ripeness.

Soil moisture together with potential transpiration may be more important:-

Lincolnshire (high glucan)	Estimated soil moisture deficit for the milk stage between 75 and 100 mm., increasing to about 130 mm. by August. Significant rain only after 23rd July.
Hampshire (high glucan)	Soil near field capacity at the beginning of July. However the estimated milk stage was rainless with high potential transpiration which may well have caused temporary wilting.
Fife (low glucan)	Potential transpiration was lower and soil moisture deficits were between 50 and 75 mm. Some rain fell at the end of the estimated milk stage.
Norfolk (low glucan)	Soil moisture deficits were quite high (80-90 mm) during the milk stage. Thunderstorms occurred on 11/12th July which gave between 1 and 7 mm. in the barley areas. This date lies in the middle of the estimated milk stage.
Devon (only 3 trials)	Some showers did fall during the milk stage, but potential transpiration was high also.

The glucan content of variety Maris Otter does not appear to follow the general pattern in Norfolk and Devon. For this variety the highest value was for Norfolk and the lowest for Devon. Since this is a winter barley all the phenological stages could be distinctly earlier than those given in the table. If the milk stage was 1 week earlier, then Norfolk was rainless (ie high glucan) and Devon had rain (low glucan).

Conclusions

It is tentatively proposed that high glucan contents are associated with soil moisture stress at the milk ripe stage. The conditions likely to produce high glucan contents are dry weather with plenty of sunshine, even with soil near field capacity. When the soil is dry it appears that one good shower at the milk stage can prevent very high glucan concentrations.

Further data is needed to confirm this.

Any comments should be sent direct to the author.

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